## CLAIMS

1.    Voice synthesis apparatus comprising:

a source module adapted to generate a raw sound signal simulating the outcome from vibrations created by the glottis, and

a filter module arranged to receive the raw sound signal produced by the source module and apply thereto a transfer function which simulates the response of the vocal tract;

characterised in that the source module comprises means for generating a succession of sound granule signals to constitute said raw sound signal and means for controlling the spectrum of the sound granule signals according to states of cells of a cellular automaton.

2.    Voice synthesis apparatus according to claim 1, wherein the apparatus is adapted to generate ultra-linguistic utterances.

3.    Voice synthesis apparatus according to claim 1, wherein the sound granule signal spectrum controlling means is adapted to generate a sound granule signal by summing the signals produced by a plurality of signal generators, the signal produced by each of the signal generators being dependent upon the state of one or more cells of the cellular automaton.

4.    Voice synthesis apparatus according to claim 3, and comprising means for designating, for each signal generator, one of a plurality of different waveforms to be output.

5.    Voice synthesis apparatus according to claim 3, wherein the sound granule signal spectrum controlling means comprises means for setting the number of signal generators used for production of the sound granule signal spectrum to one of a plurality of different possible values.

6.      Voice synthesis apparatus according to claim 3, wherein the states of the cells of the cellular automaton are each associated with respective frequency and amplitude values.

7.      Voice synthesis apparatus according to claim 6, wherein the sound granule signal spectrum controlling means comprises a plurality of signal generators, each sound signal generator being associated with a sub-grid of cells of the cellular automaton, the frequency and amplitude of the sound signal generated by each sound generator being dependent upon the state of the cells of the sub-grid with which the sound generator is associated.

8.      Voice synthesis apparatus according to claim 7, wherein the frequency ($F_i^n$) and the amplitude ($Amp_i^n$) values for each signal generator ($i$) during a cycle ($c^n$) of the cellular automaton are determined by the arithmetic mean over the frequency and the amplitude values associated with the states of the cells with which the signal generator is associated:

$$F_i^n = \{\sum_{h=1}^{H} \phi_h^n\} /H \qquad\qquad Amp_i^n = \{\sum_{h=1}^{H} \tau_h^n\} /H$$

where $\phi_h^n$ and $\tau_h^n$ are the frequency and amplitude of cell $h$ during cycle $c^n$ and $H$ is the total number of cells with which the signal generator is associated.

9.      Voice synthesis apparatus according to claim 1, wherein the cells of the cellular automaton can take states corresponding to integer values from 0 to $x$-1 and, at each cycle in the evolution of the cellular automaton, the state of each cell is updated dependent upon the states of the nearest neighbours of said cell according to the following algorithm:

$$m^{t+1} = int(A/r_1) + int(B/r_2) \qquad\qquad if\ m^t = 0$$
$$m^{t+1} = int((S/A) + k) \qquad\qquad if\ 0 < m^t < x\text{-}1$$
$$m^{t+1} = 0 \qquad\qquad if\ m^t = x\text{-}1$$

where $m^{t+1}$ is the cell state at a time period t+1 (after updating), $m^t$ is the cell state at time t (before updating), $A$ and $B$ represent, respectively, the number of cells taking state value $x$-1 and state values in the range 1 to $x$-2 amongst the eight nearest

neighbours of this cell, $S$ represents the sum of the nearest neighbours' states, $r_1$ and $r_2$ represent the cell's resistance to an increase in state value and k controls the rate of increase of state value.

10. Voice synthesis apparatus according to claim 9, wherein the sound granule signal spectrum controlling means comprises means for setting each of the parameters $r_1$, $r_2$ and k to a respective one of a plurality of different possible values.

11. Voice synthesis apparatus according to claim 1, wherein the sound granule signal spectrum controlling means comprises means for setting the dimensions of the cellular automaton to one of a plurality of different possible values.

12. Voice synthesis apparatus according to claim 1, wherein the sound granule signal spectrum controlling means comprises means for setting the number of states that can be assigned to the cells of the cellular automaton to one of a plurality of different possible values.

13. Voice synthesis apparatus according to claim 1, wherein the sound granule signal spectrum controlling means comprises means for setting the duration of the individual sound granules to one of a plurality of different possible values.

14. Voice synthesis apparatus according to claim 1, wherein the sound granule signal spectrum controlling means comprises means for setting the total number of sound granules making up the raw sound signal to one of a plurality of different possible values.

15. A method of voice synthesis comprising the steps of:
providing a source module adapted to generate a raw sound signal simulating the outcome from vibrations created by the glottis, and
providing a filter module arranged to receive the raw sound signal produced by the source module and apply thereto a transfer function which simulates the response of the vocal tract;

characterised in that the source module providing step comprises providing a source module including means for generating a succession of sound granule signals to constitute said raw sound signal, wherein the spectrum of the sound granule signals is controlled according to states of cells of a cellular automaton.

16.     A method of synthesising ultra-linguistic utterances according to claim 15, wherein a sound granule signal is generated by summing the signals produced by a plurality of signal generators, the signal produced by each of the signal generators being dependent upon the state of one or more cells of the cellular automaton.

17.     A method of synthesising ultra-linguistic utterances according to claim 16, wherein the waveform output by each signal generator is selected from one of a plurality of different waveforms.

18.     A method of synthesising ultra-linguistic utterances according to claim 16, wherein the number of signal generators used for production of the sound granule signal spectrum is set to one of a plurality of different possible values.

19.     A method of synthesising ultra-linguistic utterances according to claim 16, wherein the states of the cells of the cellular automaton are each associated with respective frequency and amplitude values.

20.     A method of synthesising ultra-linguistic utterances according to claim 19, wherein the sound granule signal spectrum controlling means comprises a plurality of signal generators, each sound signal generator being associated with a sub-grid of cells of the cellular automaton, the frequency and amplitude of the sound signal generated by each sound generator being dependent upon the state of the cells of the sub-grid with which the sound generator is associated.

21.     A method of synthesising ultra-linguistic utterances according to claim 20, wherein the frequency ($F_i^n$) and the amplitude ($Amp_i^n$) values for each signal generator ($i$) during a cycle ($c^n$) of the cellular automaton are determined by the arithmetic mean

over the frequency and the amplitude values associated with the states of the cells with which the signal generator is associated:

$$F_i^n = \sum_{h=1}^{H} \{\phi_h^n\} /H \qquad\qquad Amp_i^n = \sum_{h=1}^{H} \{\tau_h^n\} /H$$

where $\phi_h^n$ and $\tau_h^n$ are the frequency and amplitude of cell $h$ during cycle $c^n$ and $H$ is the total number of cells with which the signal generator is associated.

22.    A method of synthesising ultra-linguistic utterances according to claim 15, wherein the cells of the cellular automaton can take states corresponding to integer values from 0 to $x$-1 and, at each cycle in the evolution of the cellular automaton, the state of each cell is updated dependent upon the states of the nearest neighbours of said cell according to the following algorithm:

$$m^{t+1} = int(A/r_1) + int(B/r_2) \qquad if\ m^t = 0$$
$$m^{t+1} = int((S/A) + k) \qquad if\ 0 < m^t < x\text{-}1$$
$$m^{t+1} = 0 \qquad if\ m^t = x\text{-}1$$

where $m^{t+1}$ is the cell state at a time period t+1 (after updating), $m^t$ is the cell state at time t (before updating), $A$ and $B$ represent, respectively, the number of cells taking state value $x$-1 and state values in the range 1 to $x$-2 amongst the eight nearest neighbours of this cell, $S$ represents the sum of the nearest neighbours' states, $r_1$ and $r_2$ represent the cell's resistance to an increase in state value and k controls the rate of increase of state value.

23.    A method of synthesising ultra-linguistic utterances according to claim 22, wherein each of the parameters $r_1$, $r_2$ and k is dynamically set to a respective one of a plurality of different possible values.

24.    A method of synthesising ultra-linguistic utterances according to claim 15, wherein the dimensions of the cellular automaton are dynamically set to one of a plurality of different possible values.

25.    A method of synthesising ultra-linguistic utterances according to claim 15, wherein the number of states that can be assigned to the cells of the cellular automaton are dynamically set to one of a plurality of different possible values.

26.    A method of synthesising ultra-linguistic utterances according to claim 15, wherein the duration of the individual sound granules is dynamically to one of a plurality of different possible values.

27.    A method of synthesising ultra-linguistic utterances according claim 15, wherein the total number of sound granules making up the raw sound signal is dynamically set to one of a plurality of different possible values.